



COMMUNITY DEVELOPMENT DEPARTMENT

CITY OF SANTA BARBARA SEA LEVEL RISE ADAPTATION PLAN SUBCOMMITTEE

November 12, 2019

Agenda

- A. Comments on plan for public outreach
- B. Adaptation recommendations for the low-lying beach areas and low-lying flood areas



COMMENTS ON PLAN FOR PUBLIC OUTREACH

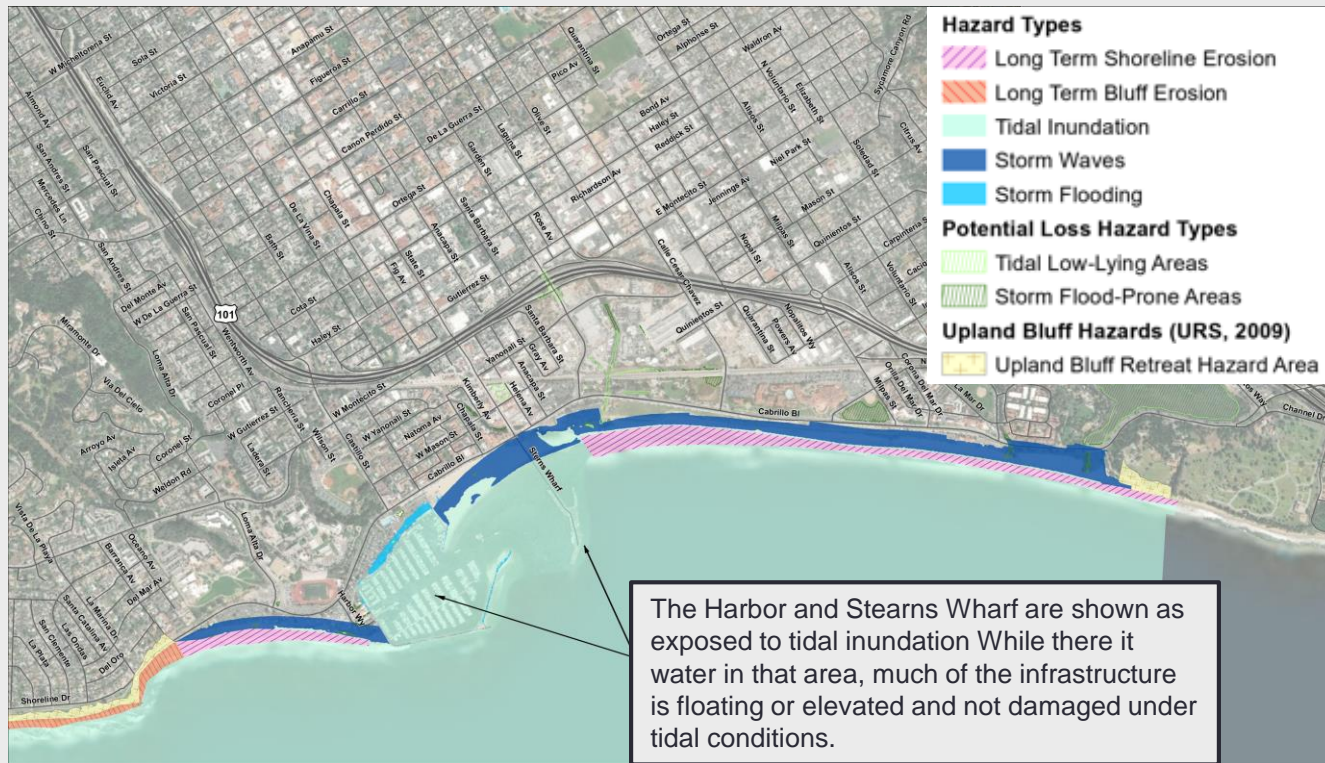
ADAPTATION RECOMMENDATIONS BEACH & FLOOD AREAS

Planning Timeframes

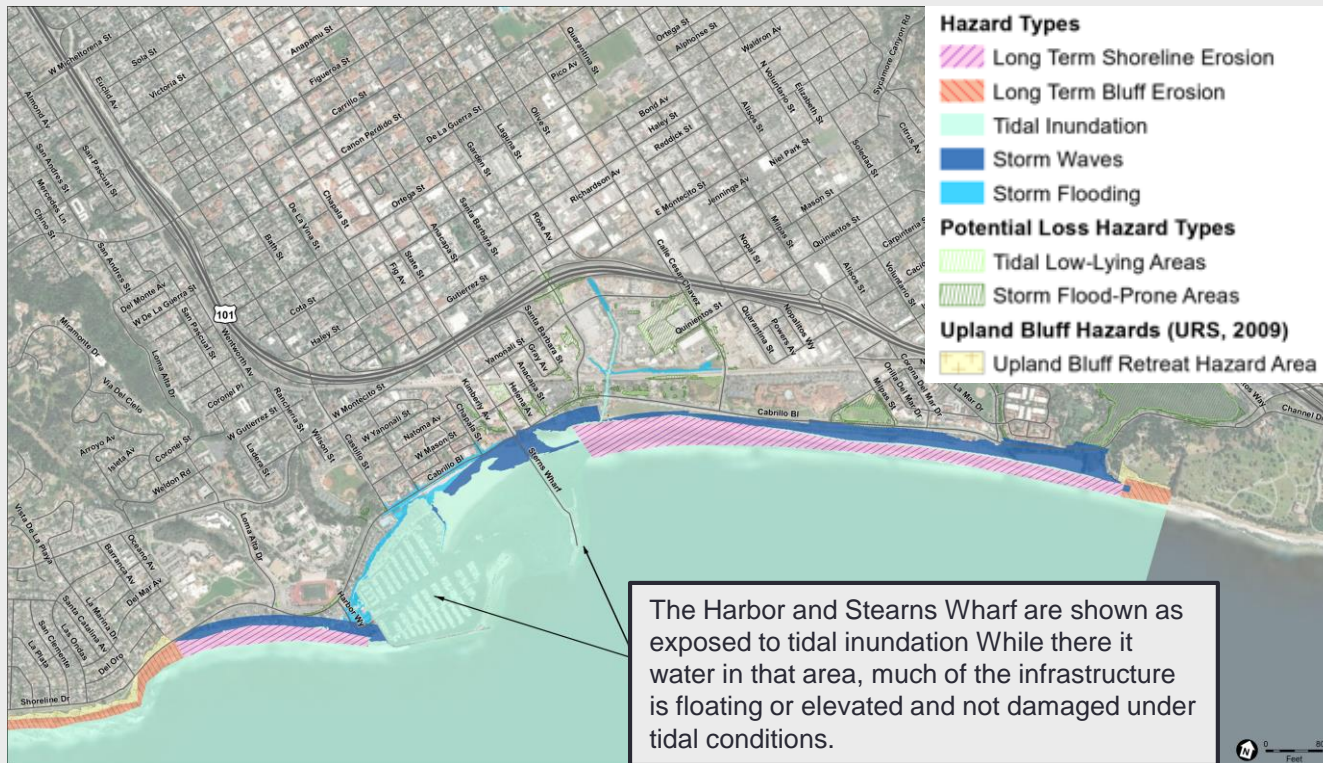
- Near-term: 0 - 0.8 feet (2020 – 2030*)
- Mid-term: 0.8 - 2.5 feet (2030 – 2060*)
- Long-term: 2.5 - 6.6 feet (2060 – 2100*)

*Medium-high risk SLR scenarios

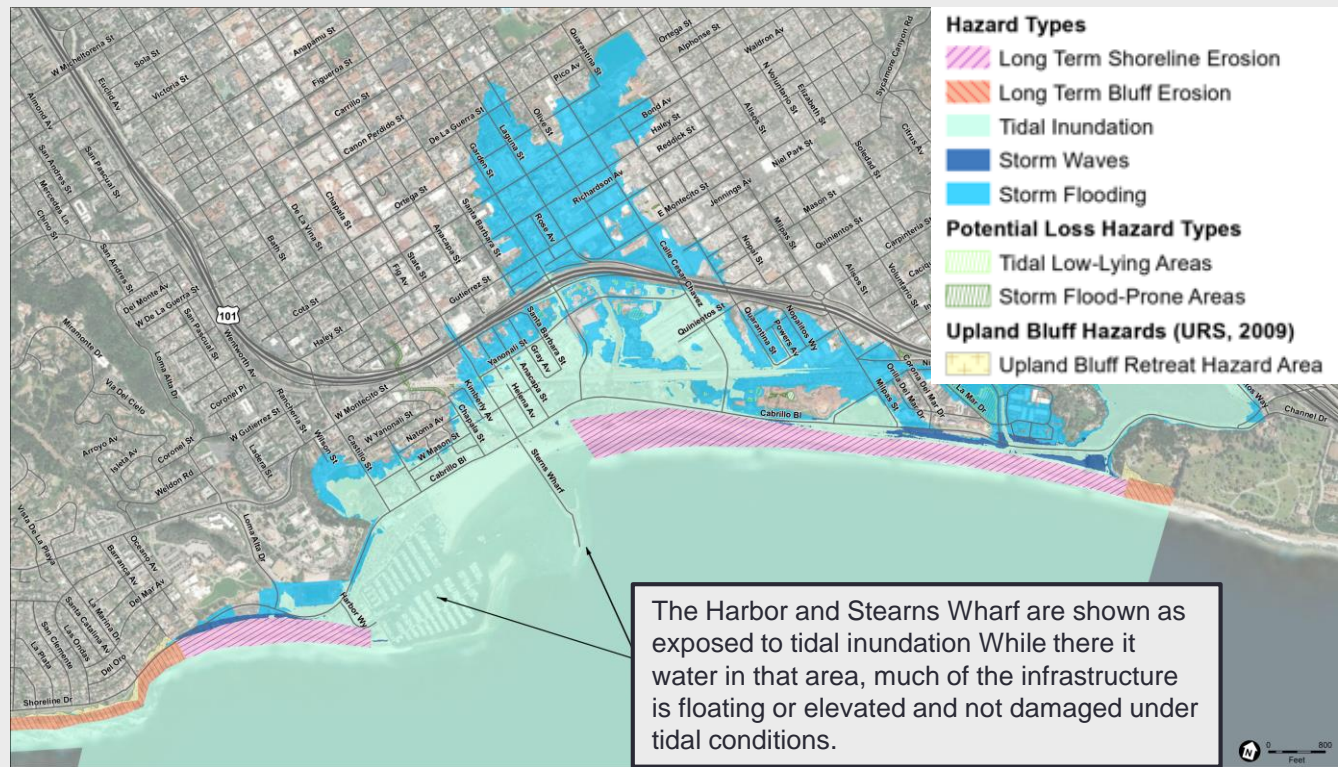
0.8 ft SLR Hazard Map: East, Waterfront, Downtown



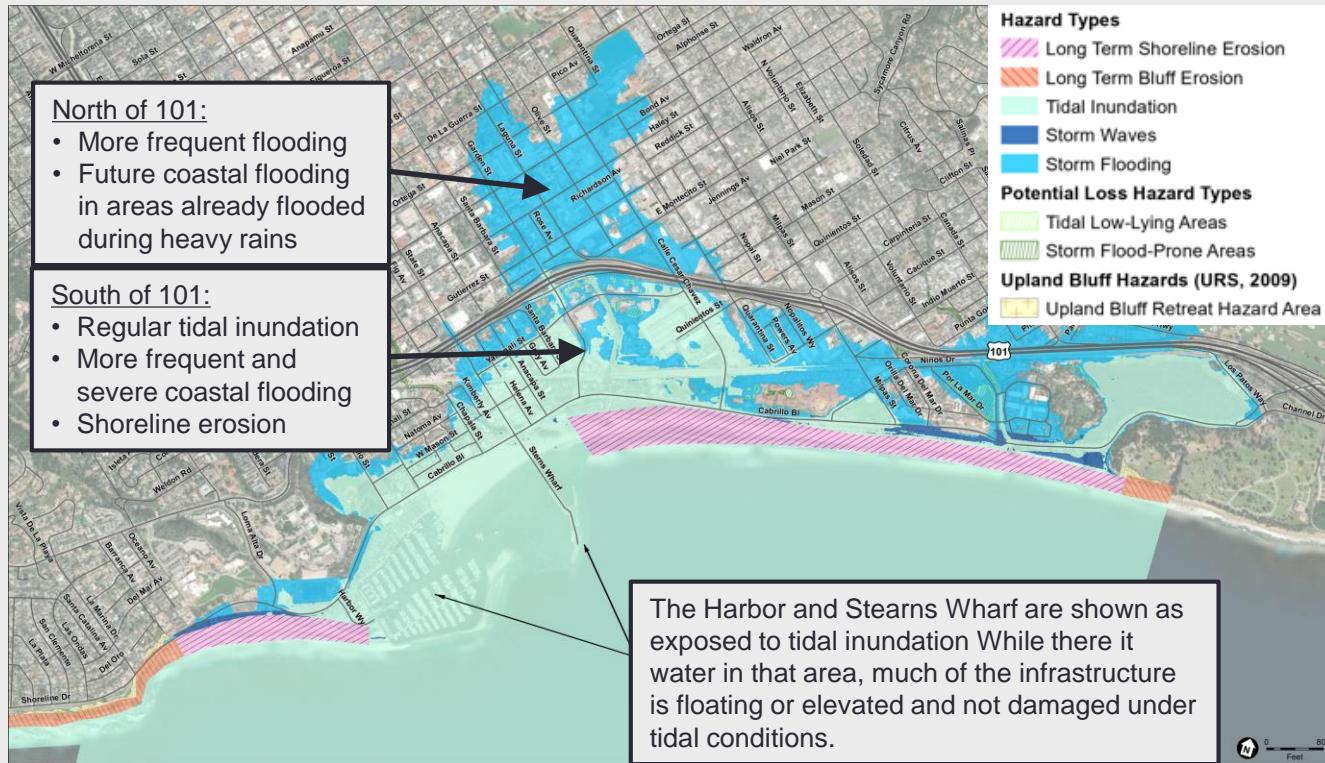
2.5 ft SLR Hazard Map: East, Waterfront, Downtown



6.6 ft SLR Hazard Map: East, Waterfront, Downtown



6.6 ft SLR Hazard Map: East, Waterfront, Downtown

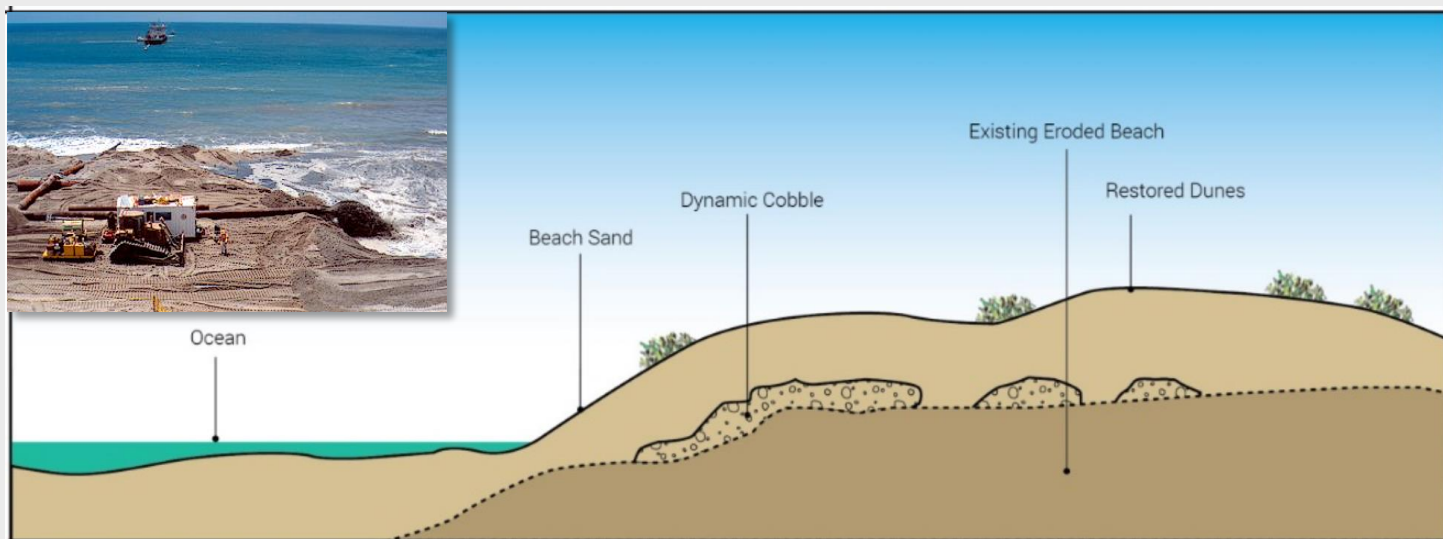


Beach Adaptation Options

- Beach nourishment
- Sand retention structures
- Shoreline protection devices
- Elevating or waterproofing structures
- Elevating property grade
- Managed retreat

Beach Nourishment

- Requires ongoing re-nourishment
- Required frequency increases with SLR

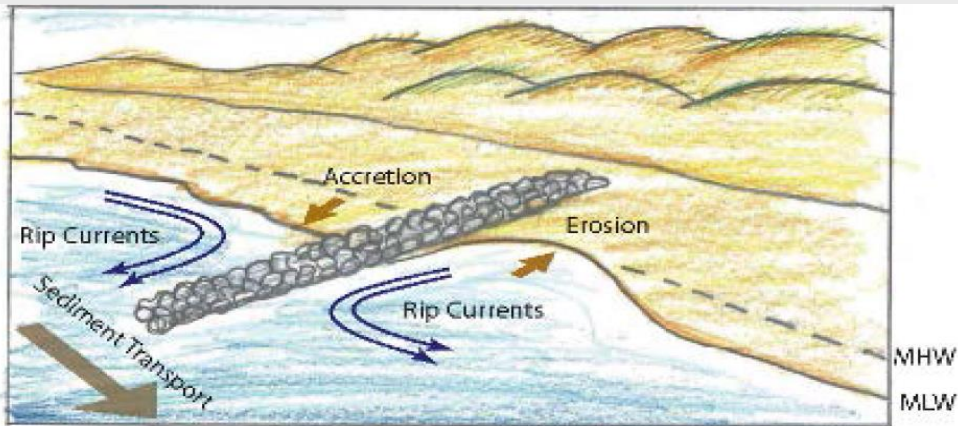


Sand Retention Structures

- Groins
- Breakwaters
- Offshore reefs

Groins

- Potential downcoast impacts
- Complex permitting



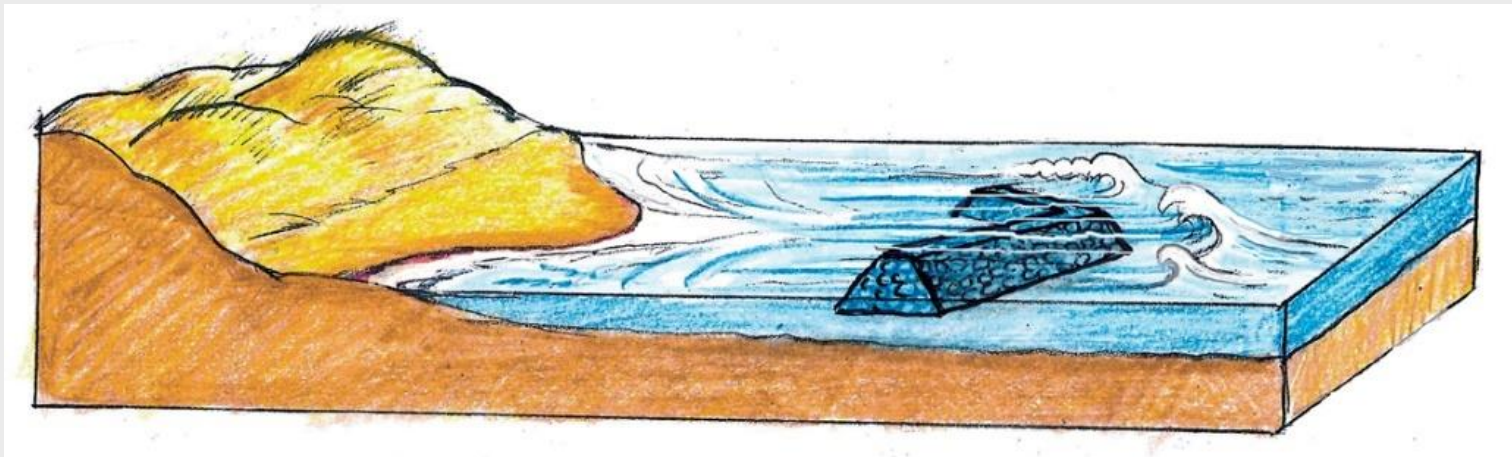
Breakwaters

- Improve existing breakwater with SLR
- New breakwaters not likely to be permitted



Offshore Reefs

- Experimental strategy
- Complex permitting



Uncertainties with more than 2 – 3 ft of SLR

- Feasibility and effectiveness uncertain due to accelerated rate of SLR and beach erosion
- Implementing multiple adaptation strategies in combination could increase effectiveness
- Do not provide protection for areas subject to tidal inundation

Shoreline Protection Devices

- Impact to beach
- Implement with 2 – 3 ft of SLR:
 - Large-scale seawall system
 - Raising Cabrillo onto new levee
- Feasibility after 3 - 5 feet of SLR unknown



Shoreline protection devices are subject to failure when bluffs collapse, as shown here in Ocean Beach, San Francisco



Source: Westside Observer 2014.
<http://www.westsideobserver.com/2014/climate.html>

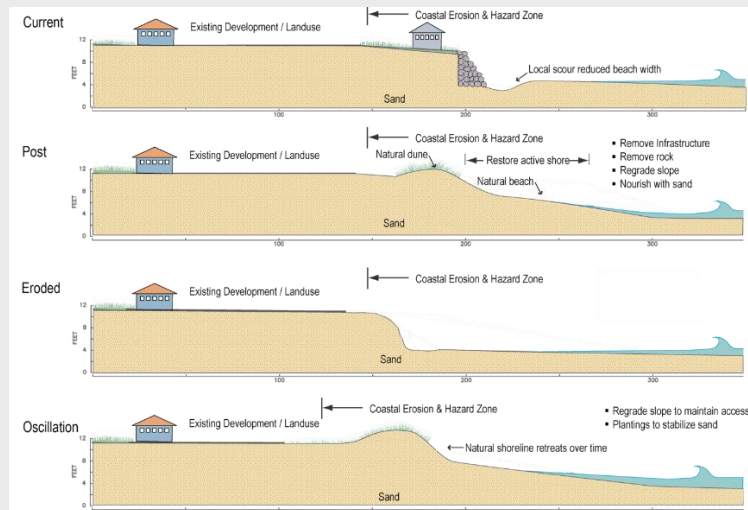
Accommodation Strategies

- Elevate or waterproof structures
- Elevate grade



Managed Retreat

- Removal of development
- Relocation of development
- Rerouting of roads
- Hazard avoidance



Beach Adaptation Framework

		0.8' rise (2030)	2.5' rise (2060)	6.6' rise (2100)
Sea-Level Rise:		NEAR-TERM	MID-TERM	LONG-TERM
Key Vulnerabilities (with no action):	By 0.8' rise:	<ul style="list-style-type: none">Storm wave impacts to:<ul style="list-style-type: none">Leadbetter BeachCabrillo PavilionEast Beach Parking LotWaterfront Parking LotCabrillo Blvd. between Niños Dr. and Andr��e Clark Bird Refuge	<p>By 2.5' rise:</p> <ul style="list-style-type: none">Loss of 32% of sandy beaches to erosionErosion and regular tidal inundation cause loss of 28% of recreational, open space, and park areasStorm wave impacts to:<ul style="list-style-type: none">Shoreline Blvd. near Leadbetter BeachCabrillo Blvd. by Stearns WharfSewer and water supply infrastructure	<p>By 6.6' rise:</p> <ul style="list-style-type: none">Loss of 60% of sandy beaches to erosionErosion and regular tidal inundation cause loss of 67% of recreational, open space, and park areasTidal inundation impacts to:<ul style="list-style-type: none">Area northeast of Cabrillo Blvd. by Harbor and Stearns WharfCabrillo Blvd.Cabrillo PavilionEast BeachStorm wave impacts to:<ul style="list-style-type: none">Cliff Dr. and Alan Rd.Sewer and water supply infrastructure
	Options for Near-Term			
	Optimize sand bypassing at East Beach			
	Plan & Permit	Expand beach nourishment program at East Beach, Leadbetter Beach, and Arroyo Burro Beach		
	Plan & Permit	Raise walkways, add select shoreline protection, elevate and flood-proof development, or remove select public facilities as needed		
POTENTIAL ADAPTATION APPROACHES	Additional Options for Mid- to Long Term	Plan & Permit	Construct groins or artificial reef if additional study shows feasible	Feasibility unknown
		Plan & Permit	Build a 10-15-foot seawall along Cabrillo Boulevard to protect the road and assets north of the road. Will result in faster erosion of beach.	Feasibility unknown
		Plan & Permit	Raise Cabrillo Boulevard, Shoreline Drive, and/or Cliff Drive, associated roads, and other public infrastructure	
		Plan & Permit	Remove or relocate development	

Recommended Near-Term Actions

- Shoreline monitoring program
- Study options for relocation and/or flood proofing of major wastewater, water, and utility infrastructure south of Cabrillo Boulevard
- Study and implement options for additional beach and dune nourishment
- Work with BEACON to update 2009 Coastal Regional Sediment Management Plan to factor in sea-level rise

Recommended Near-Term Actions

- Continue current regulatory practices:
 - *Limitations on uses in the waterfront and beach areas*
 - *Requirements that new development and substantial redevelopment be designed to avoid and mitigate hazards associated with sea-level rise*
- As needed, consider options such as shoreline protection, flood proofing, removal, or relocation of select public facilities as they are redeveloped or become threatened.

Recommended Near-Term Actions

- Further study specific beach width thresholds for initiating consideration and planning for large-scale adaptation options along the waterfront and beach areas.

Flood Area Adaptation Options

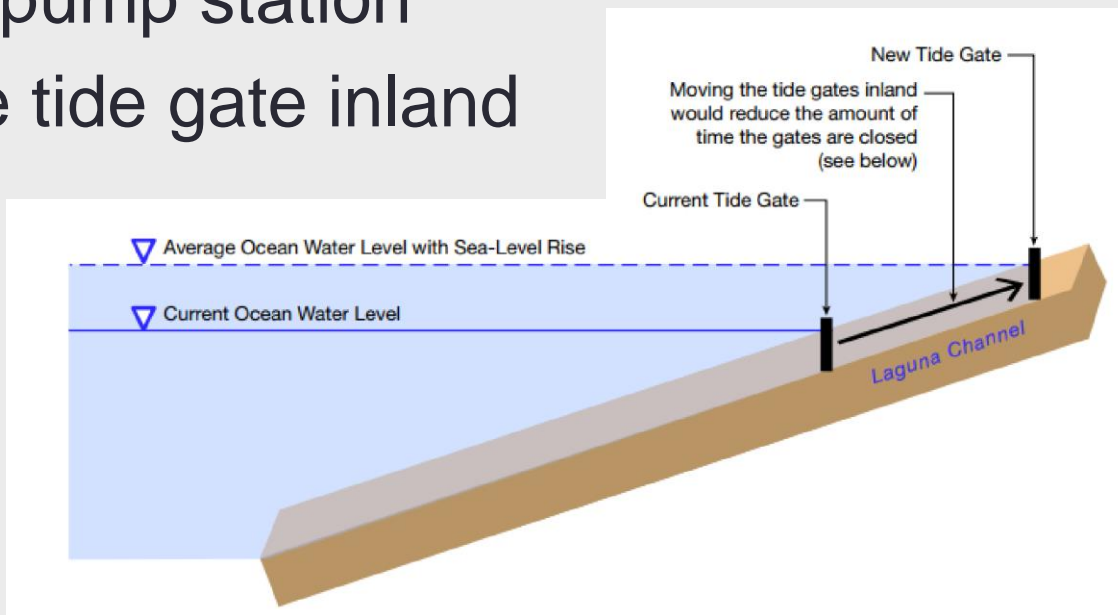
- Tide gates and weirs
- Groundwater pumping
- Creek flood walls or levees
- Elevating or waterproofing structures
- Elevating property grade
- Shoreline protection devices
- Managed retreat

Flood Area Adaptation Options

- Tide gates and weirs
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Laguna Creek Tide Gate Upgrade

- New pump station
- Move tide gate inland



Andrée Clark Bird Refuge Weir

- Restoration and weir replacement in design
- Options with SLR:
 - Raise new weir/tide gate
 - Integrate with new seawall
 - Install pump system

Creek Flood Walls/Levees

- Levees: Andrée Clark Bird Refuge, Arroyo Burro Creek
- Flood walls: Mission, Laguna, Sycamore Creeks
- Connect with seawalls
- Pumps to convey stormwater over flood walls

Groundwater Pumping

- Lower increase in groundwater table due to SLR
- System to discharge groundwater
- Assessing feasibility beyond scope of Adaptation Plan

Adaptation Strategy Combination

Potential to combine strategies to improve effectiveness in the mid- to long-term:

- Seawall
- Creek flood walls/levees
- Stormwater pumping
- Groundwater pumping

Uncertainties with 3 – 5 ft of SLR

- Effectiveness with accelerated rate of SLR
- Groundwater hazards and pumping studies needed
- Potential increase in rainfall intensity not considered

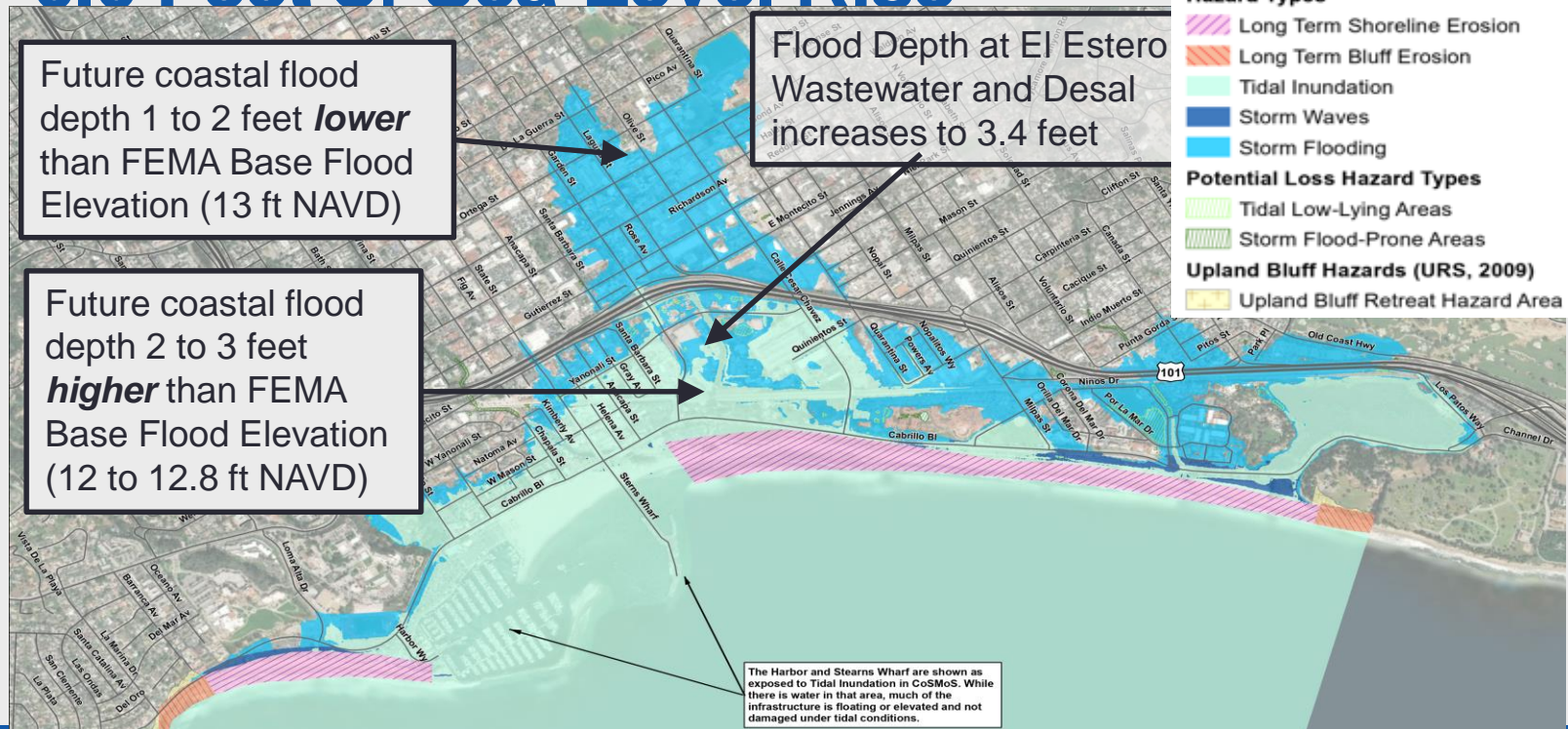
Floodplain Regulations

- City's floodplain regulations require building above base flood elevation and flood proofing buildings
- City's existing floodplain regulations based on FEMA FIRMS and existing hazards
- City could consider altering floodplain regulations to factor in sea-level rise

FEMA Flood Zones: Reflect Current Hazards



6.6 Feet of Sea-Level Rise



Managed Retreat



- Moving, removing, or limiting accessory development
- Moving development farther back on same parcel
- Moving or removing non-critical infrastructure
- Moving assets within public parks
- Moving infrastructure when alternate location exists
- Entire parcel is at risk
- Relocating major public assets and rerouting major roads

Flood Area Adaptation Framework

		0.8' rise (2030)	2.5' rise (2060)	6.6' rise (2100)
Sea-Level Rise:		LONG-TERM		
NEAR-TERM		MID-TERM		
Key Vulnerabilities (with no action):		By 0.8' rise: <ul style="list-style-type: none"> Continued flooding along creeks, similar to existing 	By 2.5' rise: <ul style="list-style-type: none"> More frequent flooding along Laguna, Mission, and Arroyo Burro Creeks 	By 6.6' rise: <ul style="list-style-type: none"> Increased frequency of flooding of areas north of Highway 101 as sea levels back up into creek channels Tidal inundation and increase in extent and depth of storm flooding south of Highway 101 Coastal flooding overtops Cabrillo Boulevard at Andrée Clark Bird Refuge and floods Highway 101
POTENTIAL ADAPTATION APPROACHES	Options for Near-Term	Plan & Permit	Upgrade tide gates and weirs at Laguna Creek and Andrée Clark Bird Refuge	
		Plan & Permit	Modify floodplain ordinances to elevate and waterproof new development and substantial redevelopment	
		Plan & Permit	Modifications to sewer system and other utilities	
	Additional Options for Mid- to Long Term	Plan & Permit	Install dewatering wells across low-lying areas to achieve a lowered groundwater table	
		Plan & Permit	Install pumps to remove stormwater from low-lying areas during rain events	
		Begin planning for relocation of public assets	Abandon or relocate structures and infrastructure in low-lying areas	
		Plan & Permit	Build levees or flood walls along the creeks in addition to raising or building a sea wall along Cabrillo Boulevard, associated roads, and other public infrastructure	Feasibility unknown

Recommended Near-Term Actions

- Reconstruct and possibly relocate the Laguna tide gate and pump system.
- Conduct a study to assess extreme rainfall runoff and creek discharge flooding in Laguna Channel with climate change and sea-level rise.

Recommended Near-Term Actions

- Improve the existing tide gate and weirs at Andree Clark Bird Refuge (in progress).
Conduct a study to assess impacts of sea-level rise on Andree Clark Bird Refuge.
- Evaluate City's floodplain ordinance for new development and redevelopment in flooding areas impacted by sea-level rise, particularly south of Highway 101

Recommended Near-Term Actions

- Initiate study of changes in flooding as a result of:
 - *Fluvial flood events interacting with higher sea levels and*
 - *Changes in rainfall and fluvial flooding due to climate change.*
- Develop monitoring and adaptation thresholds for creek flooding.

Recommended Near-Term Actions

- Conduct a study to analyze existing groundwater elevations, the freeboard from typical levels, and potential impacts of sea-level rise. Study the feasibility of groundwater pumping to lower the water table.
- Study feasibility of creek floodwalls, tide gates, continuous seawall, levees, or other measures to prevent inundation and storm flooding.

Major Infrastructure Near-Term Actions

- Initiate a study of options for the wastewater system including redesign of system, adaptation options for El Estero Water Resource Center, and possible service point improvements.

Major Infrastructure Near-Term Actions

- Coordinate with electrical and natural gas utility providers to assess impact to energy transmission and distribution systems
- Initiate study of potential impacts to the storm water system

East City Adaptation Scenario Analysis

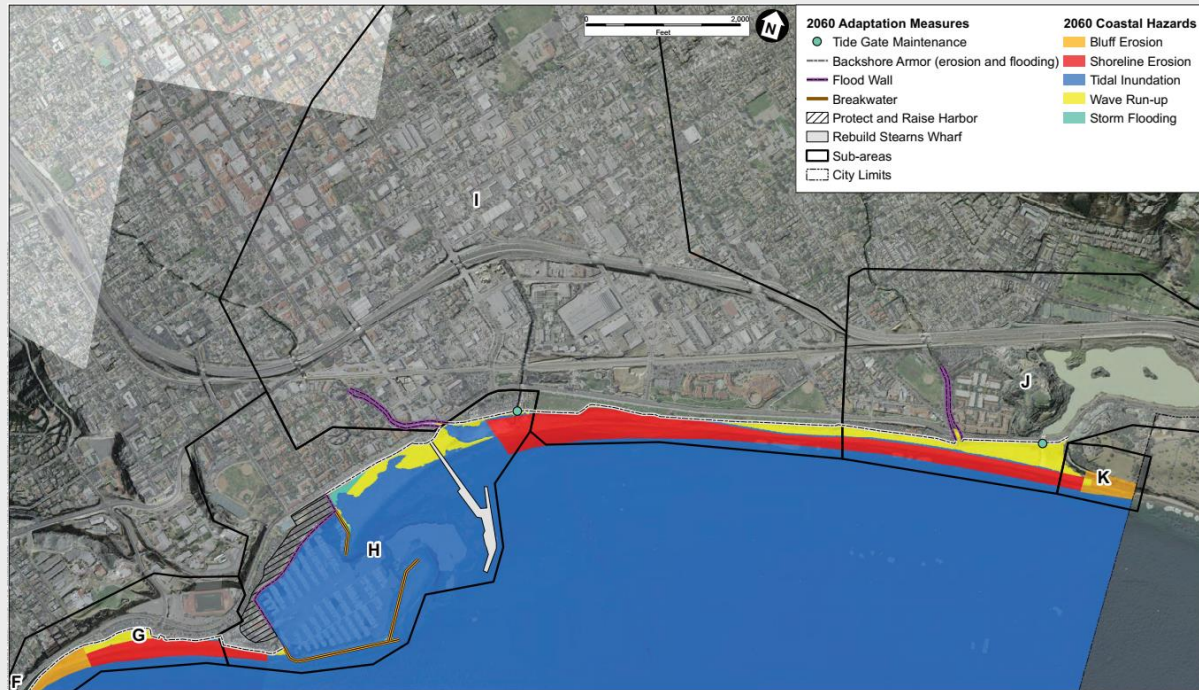
- Comparison of “No Action” with one potential adaptation scenario
 - Not intended as proposed or preferred approach
 - City will have flexibility to implement different strategies
- Economic benefit-cost analysis or scenarios
 - Compares relative costs/benefits of “No Action” with adaptation
 - Provides high-level understanding of costs/benefits of adapting

East City Adaptation Scenario Analyzed

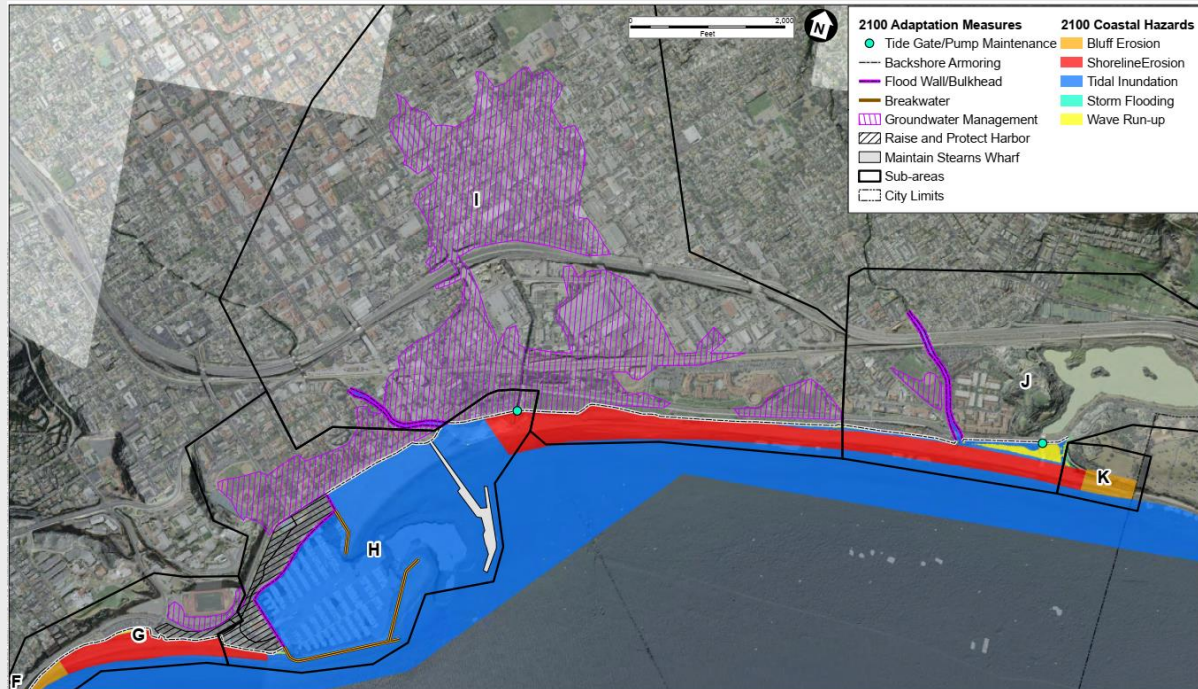
Protect:

- Maintain and expand coastal structures
- Increase beach nourishment
- Build/upgrade flood protection structures
- Raise breakwater and lands around harbor
- Rebuild Stearns Wharf
- Manage rising groundwater

East Adaptation Scenario – 2.6 ft SLR



East Adaptation Scenario – 6.6 ft SLR



East Adaptation Scenario Results

- Reduces impacts and provides economic benefit
- Nourishment included does not maintain beach width
- When combined with Bluff Retreat/Protect Hybrid, benefits (\$340M) are greater than costs (\$310M)

Questions or Comments?

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- Contact: Melissa Hetrick, Community Development Department mhetrick@SantaBarbaraCA.gov